Maine Department

Of

Environmental Protection

DISPENSER AND SUBMERSIBLE PUMP STUDY

Conducted by

Marcel Moreau Associates

Portland, Maine

October 2003

TABLE OF CONTENTS

Volume 2

Facility List by Registration Number

Facility List by Name of Facility

Facility List by Town

Copies of Original Site Checklists

Volume 3

Compact disc of photographs taken during the study

BACKGROUND

Over the course of the last 15 years, the threat of petroleum releases into the Maine environment from underground petroleum storage systems has been greatly reduced. Virtually all active storage systems are now protected against corrosion and about half the storage system population is secondarily contained. However, in recent years there have been several significant releases to the environment that have occurred as a result of leaks from motor fuel dispensers and pumping systems.

Historically, contamination beneath gasoline dispensers has been commonplace. This contamination has generally been assumed to be the result of leaks within the dispenser cabinet and from poor maintenance practices (e.g., draining used filters into the soil beneath the dispenser). Contamination around submersible pumps has also been commonplace. This contamination has been assumed to be the result of loose seals and fittings on the pump itself or piping fittings immediately adjacent to the pump. Although containment sumps are commonly used to contain releases from both dispensers and pumps in newer facilities, contamination problems have resulted when the sumps, which are intended to be liquid tight, have leaked.

Presently, few release detection regulations address dispenser components and submersible pumps. Though leaks in these areas are readily visible, it is not common practice to inspect these components on a routine basis. Consequently, leaks in dispensers and submersible pumps may persist over an extended period of time if secondary containment is absent or defective.

The Maine Department of Environmental Protection (DEP) initiated this study to assess the environmental threat posed by petroleum dispensing and pumping equipment by quantifying the frequency and severity of leaks from this equipment.

PURPOSE

The purpose of this study was to quantify the frequency and estimate the severity of leakage from motor fuel dispensers and submersible pumping systems associated with underground storage systems.

The study goals were to answer the following questions:

- What is the frequency and severity of leakage from specific components of petroleum dispensers such as meters, filters, unions, and impact valves?

- What is the frequency and severity of leaks observed from suction and submersible pumps?

- What percentage of pumps and dispensers are equipped with containment sumps and leak detection sensors?

- What percentage of containment sumps beneath pumps and dispensers have liquid in them, and how much and what type of liquid (water or product) is present?

- What is the level of soil contamination present beneath pumps and dispensers that are not equipped with containment sumps?

Based on the answers to these questions, the study was to evaluate the following:

- Should containment under pumps and dispensers be required at all facilities?

- What steps could be taken to minimize leaks from dispensers and pumps?

METHODOLOGY

The basic approach for the study was to conduct a careful visual inspection of the dispensers and pumps at 100 randomly selected motor fuel dispensing facilities in Maine. These inspections were performed between May and November of 2002. The procedures used in carrying out the study are described in the sections that follow:

Selection of Facilities to be Inspected

The Maine DEP randomly selected 100 registered underground storage facilities from the DEP database. Retail, commercial, and government owned storage facilities were included in the selection. An initial review of the list of selected facilities discovered six locations that contained only emergency generator storage systems and one location that was no longer in operation. To replace these facilities, an additional seven facilities were randomly selected from the DEP database and added to the original list. This list of 100 active motor fuel facilities was referred to as the “A” list.

Because participation in the study was voluntary, we anticipated that some storage system owners would refuse permission to inspect their facilities. To deal with this contingency, a second list of 100 randomly selected facilities, called the "B" list, was also created by the DEP. The study protocol called for substituting a facility from the "B" list whenever a facility owner on the "A" list refused to participate in the study. Facilities on the "B" list were selected by the study investigators based on geographic proximity and similarity in size and type to the "A" list facility where an inspection was refused.

During the field work, eleven facilities from the "B" list were selected for inspection for the following reasons:

- three instances where an inspector was denied access to a site
- three instances involving large manufacturing facilities where it was anticipated that security concerns would preclude unannounced inspections
- two instances where sites were closed
- one unattended site
- one military facility where it was anticipated that security concerns would preclude an unannounced inspection
- one facility that presented unacceptable safety hazards to inspection personnel because of heavy traffic in a very cramped location.

Project Personnel

David McCaskill of the Maine DEP served as the project manager for this study. Peter Moulton of the Maine DEP created the lists of facilities to be inspected from the Maine DEP database and provided detailed comments on several drafts of this report. To carry out the field work, the Maine DEP contracted with Marcel Moreau Associates. Inspections were carried out by Marcel Moreau and Elizabeth Snowman of Marcel Moreau Associates and Christopher Baldwin of Baldwin Engineering. Project data management was the responsibility of Elizabeth Snowman. Marcel Moreau was the principal author of this report. All of the project personnel had extensive experience with underground storage systems and motor fuel dispensing systems.

Project Protocol

Protocol for the inspections required that inspectors introduce themselves to on-site personnel, present a letter of introduction on DEP letterhead briefly explaining the study, and request permission to conduct the inspection. With permission granted, inspectors barricaded dispensers one at a time, removed the side panels of the dispenser, and visually inspected the various components of the dispenser. The inspectors completed a detailed checklist to document what was observed and took digital photographs of each feature of interest.

Where submersible pumps were present, inspectors uncovered the pumps and visually inspected various components of the pump and adjacent piping. Inspectors completed a separate, detailed checklist and again took digital photographs to document each feature of interest.

Where liquid was present within secondary containment, the inspectors used water and product finding paste in conjunction with an appropriate-length stick to determine the depth and type of liquid that was present. Where soil was present beneath the dispenser or submersible pump, inspectors took a soil sample and screened the sample for hydrocarbon contamination with a photo ionization detector (PID) using the standard DEP protocol.

At the conclusion of the inspection, inspectors gave a one page summary of the results to a responsible on-site person. If the on-site person was not the owner, inspectors also mailed a copy of the results to the person listed as the owner on the DEP facility registration form.

Maine regulations (Chapter 691, 5D(11)) define certain conditions that are considered to be "evidence of a leak" and must be reported to the DEP when they are discovered. Where evidence of a leak was discovered during an inspection, inspectors informed on-site personnel of their responsibility to report the leak to the Maine DEP. Inspectors also independently reported the evidence of a leak to the Maine DEP. In most cases, leak reporting by both the facility and study personnel was accomplished by faxing the inspection summary page to the Maine DEP.

Observation of any one of the following conditions during an inspection would trigger a report of "evidence of a leak" to the Maine DEP:

- Product dripping from a dispenser or pump.
- The presence of product in a dispenser or piping sump.
- Soil hydrocarbon contamination greater than 100 ppm (as measured by a PID using a bag headspace technique) beneath a dispenser or submersible pump.

For purposes of this study, "leaks" also included the observation of "stains" and "weeps" on dispenser and pump components. These terms are defined and illustrated on pages 12-15 of this report. Though not considered significant enough to trigger the Maine DEP "evidence of a leak" reporting requirement, these indications of small scale product leakage were considered important to the goals of the study and were included in the data gathered for this project.

Elizabeth Snowman entered field data into an Access database specially designed for this study. Ms. Snowman also summarized the data using Excel spreadsheets, and developed charts using Excel software.

The complete protocol followed during the inspections is presented in Appendix A of this report. Copies of the checklists and accompanying instructions for completing the checklists are presented in Appendix B. Copies of the letter of introduction and inspection results forms used in the study are presented in Appendix C. Photographs taken during the study and an index of the photographs, as well as an electronic version of this report, the Access database, and the Excel spreadsheets are contained in a compact disk (CD) presented to the DEP.

QUALITY CONTROL

The following measures were taken to ensure data quality:

- A detailed protocol of inspection procedures was drafted, field-tested, revised and finalized to guide the inspectors.
- All of the field work was conducted by the same three knowledgeable inspectors who were involved in the project from start to finish. This minimized data quality issues that often result from using a large number of field investigators with varied backgrounds and experience.
- The first five inspections were jointly conducted with all three inspectors so that everyone would conduct the inspections in a similar manner.
- Most inspections were conducted with two inspectors. Having two inspectors expedited the labor-intensive inspections at the larger facilities and helped ensure consistency by allowing inspectors to discuss issues and observe each other's work.

PRESENTATION OF DATA

Results of the study are presented using graphs and tables in the following pages. Observations concerning the data are presented alongside the charts and tables to facilitate the reading of the report.

Figure 1: Where Were the Inspections Conducted?

Table 1: Where Were the Inspections Conducted?

COUNTY	NUMBER OF FACILITIES
Androscoggin	8
Aroostook	10
Cumberland	13
Franklin	4
Hancock	4
Kennebec	10
Knox	4
Lincoln	0
Oxford	7
Penobscot	10
Piscataquis	5
Sagadahoc	3
Somerset	8
Waldo	5
Washington	2
York	6
Total	99

Although 100 facilities were inspected, only 99 are included in the study results. Maine DEP requested that a facility where an ongoing leak was suspected be included in the inspections conducted for this study. Because this facility was not randomly selected, the inspection was not unannounced, and the owner acknowledged conducting some maintenance work prior to the inspection, the results of this inspection are not included in the study results.

Figure 2: What Type of Facility Was Inspected?

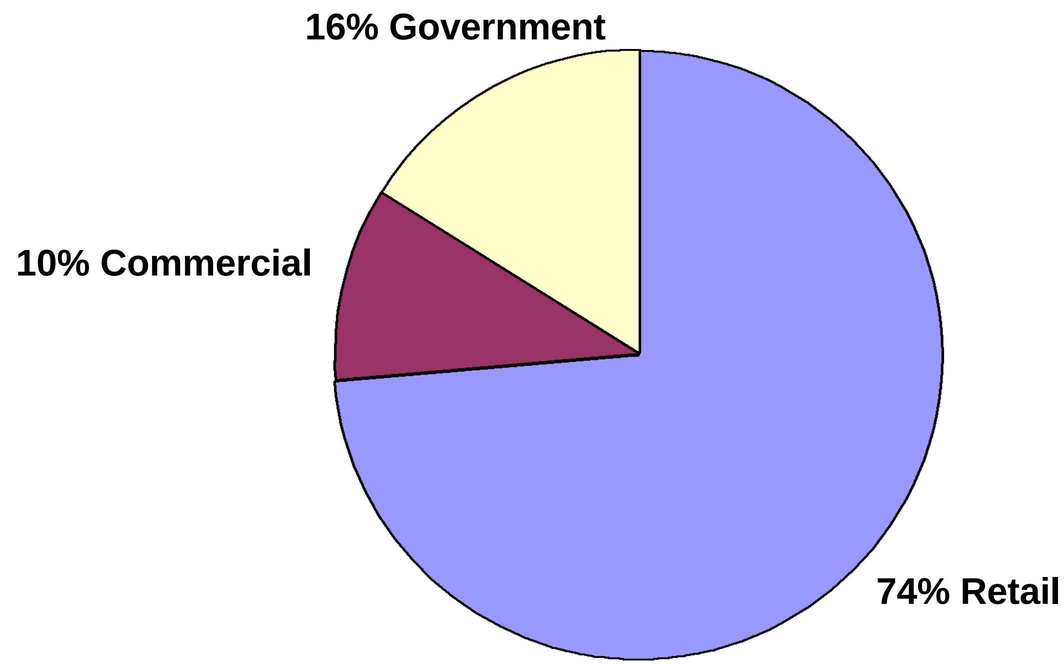
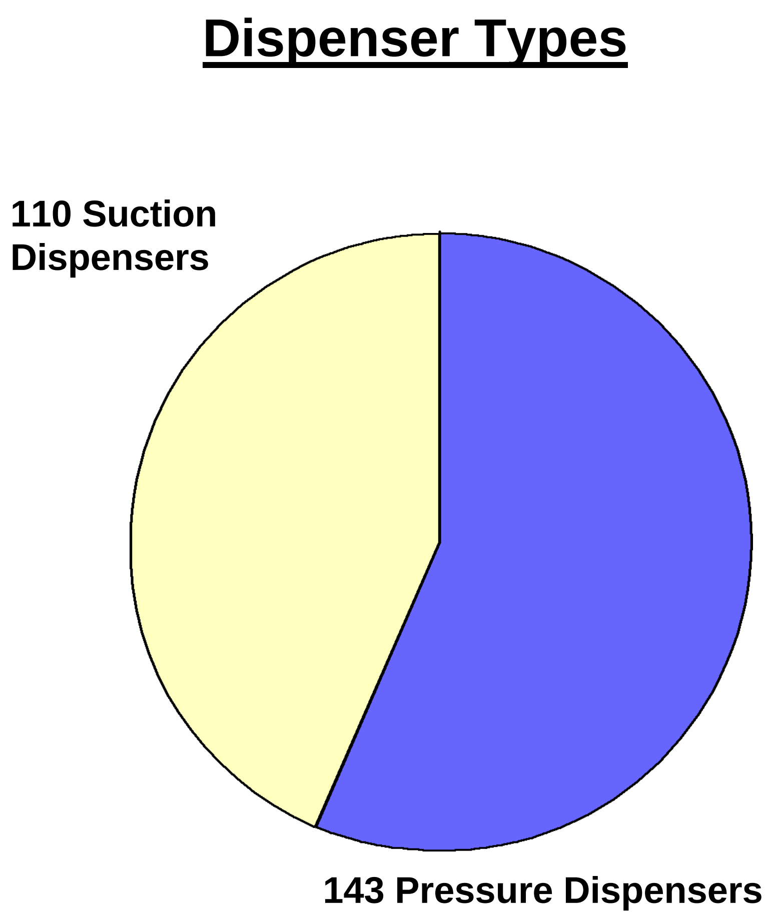


Table 2: What Type of Facility Was Inspected?

	NUMBER	PERCENT
RETAIL	73	73.7
GOVERNMENT	16	16.2
COMMERCIAL	10	10.1
TOTALS	99	100.0

Retail facilities inspected ranged from large convenience store operations owned by major corporations to small "mom and pop" locations. Retail locations also included several automobile repair facilities, two marinas and one campground. Commercial sites included construction, manufacturing and lumber operations where underground storage systems were used to fuel private fleets. Government sites included Maine Department of Transportation facilities and several town garages. Appendix D contains a listing of each of the facilities inspected.

Figure 3: How Many Dispensers and Pumps Were Inspected?



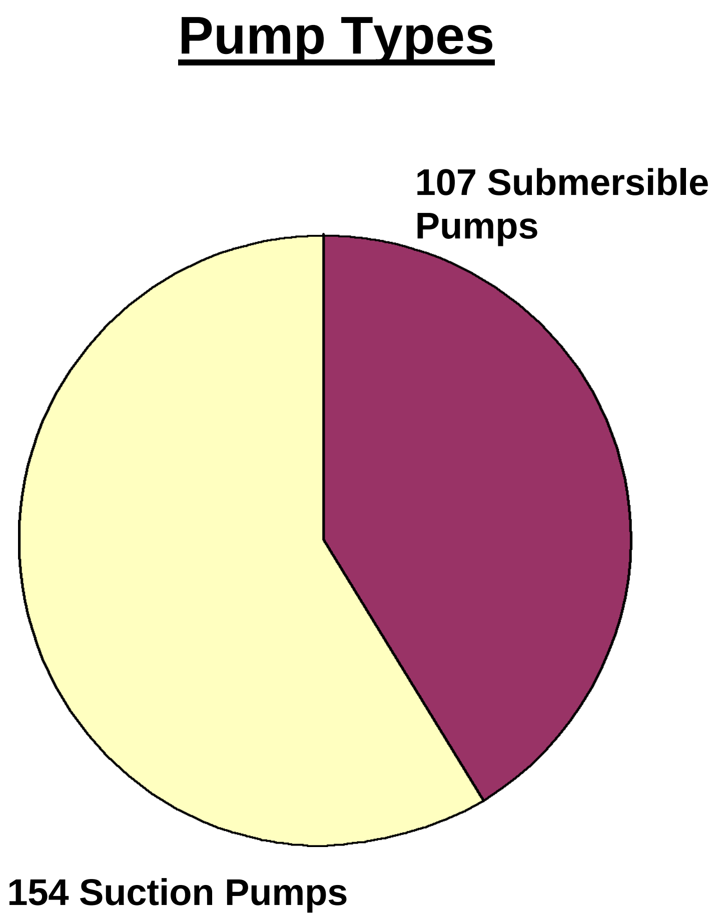


Table 3: How Many Dispensers and Pumps Were Inspected?

	Dispensers	
	Number	Percent
Pressure	143	56.5
Suction	110	43.5
Total Inspected	253	100.0

	Pumps	
	Number	Percent
Submersible	107	41.0
Suction	154	59.0
Total Inspected	261	100.0

When used in this report, the terms listed below have the following meanings:

Submersible pump The portion of a submersible pump mechanism that is mounted on a riser pipe above an underground tank, together with associated components such as line leak detectors, functional elements, shut-off valves, and flex connectors.

Suction pump The pump mechanism inside a dispenser that moves product from the underground tank by reducing the pressure in the below-grade piping. Though located inside a dispenser cabinet, for purposes of this study leaks from suction pumps are considered a separate category than leaks from other dispenser components.

Suction Dispenser A cabinet and enclosed fuel handling and metering components that contains one or two suction pumps.

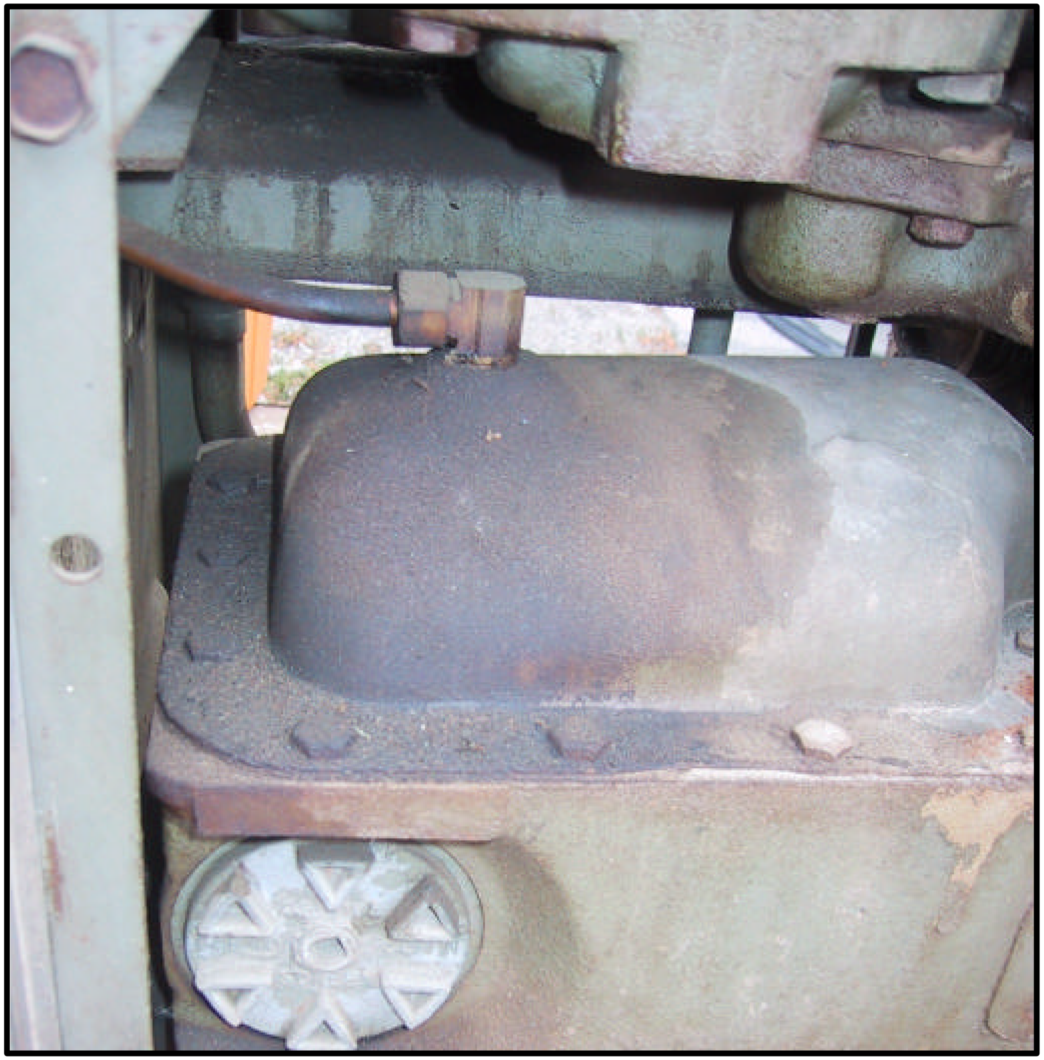
Pressure Dispenser A cabinet and enclosed fuel handling and metering components that are supplied with fuel from a submersible pump located in an underground tank.

Dispenser A generic term that includes both suction and pressure dispensers.

Table 4: What Terms Were Used to Describe Leak Severity?

The charts and tables on the following pages present the study findings concerning the occurrence of leakage from various components of suction and pressure dispensers and suction and submersible pumps. Observations of the severity of leakage were ranked using the terms stain, weep and drip. These terms are defined in the following table. Pictures representative of each term are presented on the following pages.

STAIN	Discoloration is evident on the external surface of the pipe or fitting, but there is no liquid present. Product finding paste does NOT change color when applied to the stained area. Stains are interpreted to be areas where leakage occurred in the past, but the leak is no longer active.
WEEP	Wetness is evident on the external surface of the pipe or fitting, but there is no liquid forming droplets or flowing very far away from the area of the weep. Product paste DOES change color when applied to the area of the weep. Weeps are interpreted to be areas where product is actively leaking but the rate of leakage is slow enough that the product is evaporating before it can travel very far from the leak site.
DRIP	Droplets of product can be observed dripping from a fitting or low point on the piping, or a small stream of product may be running down the side of the piping. Liquid may accumulate in the sump (if present), or there may be stained soil or staining of the concrete pump island below the drip.

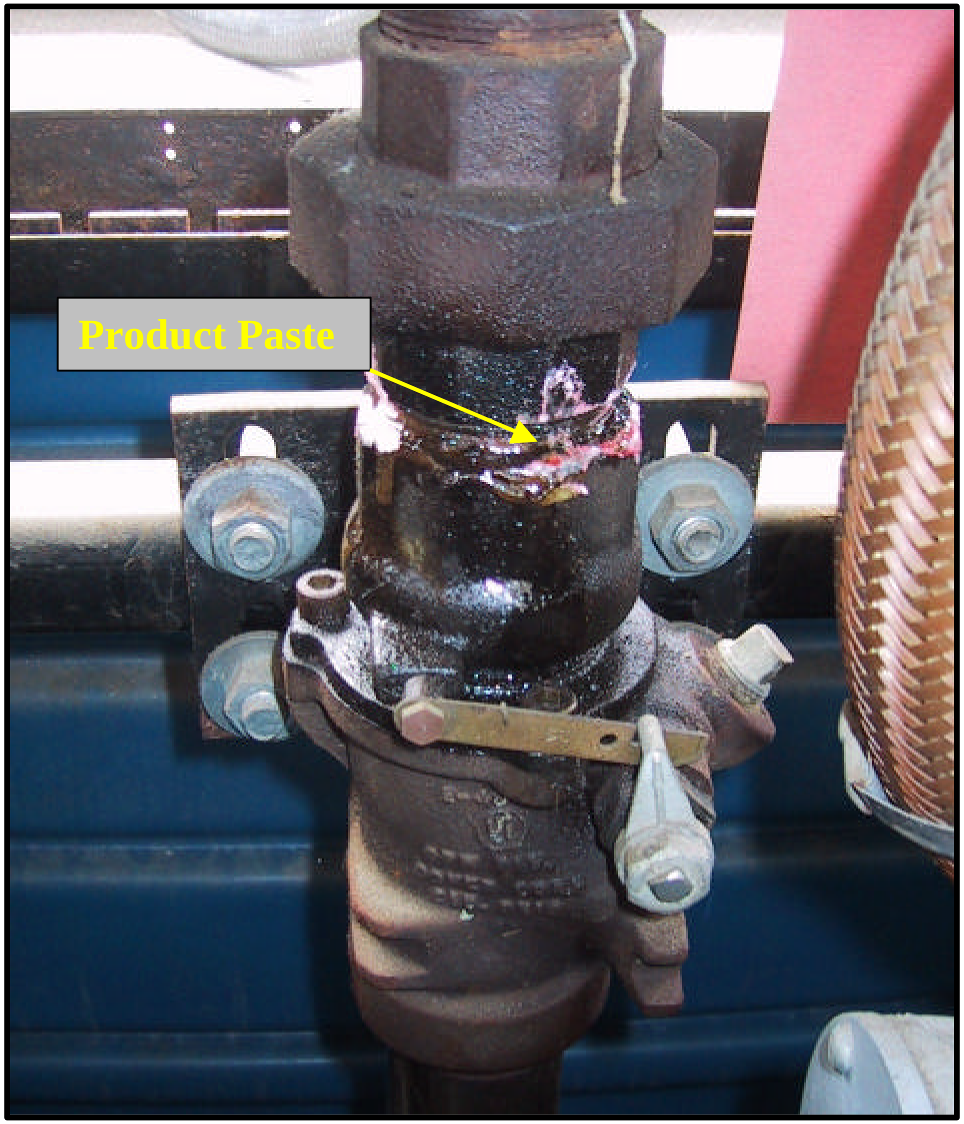


What is a Stain?

Visible discoloration likely due to product that has evaporated in the past.

Dry to the touch.

Product finding paste does not change color when applied.

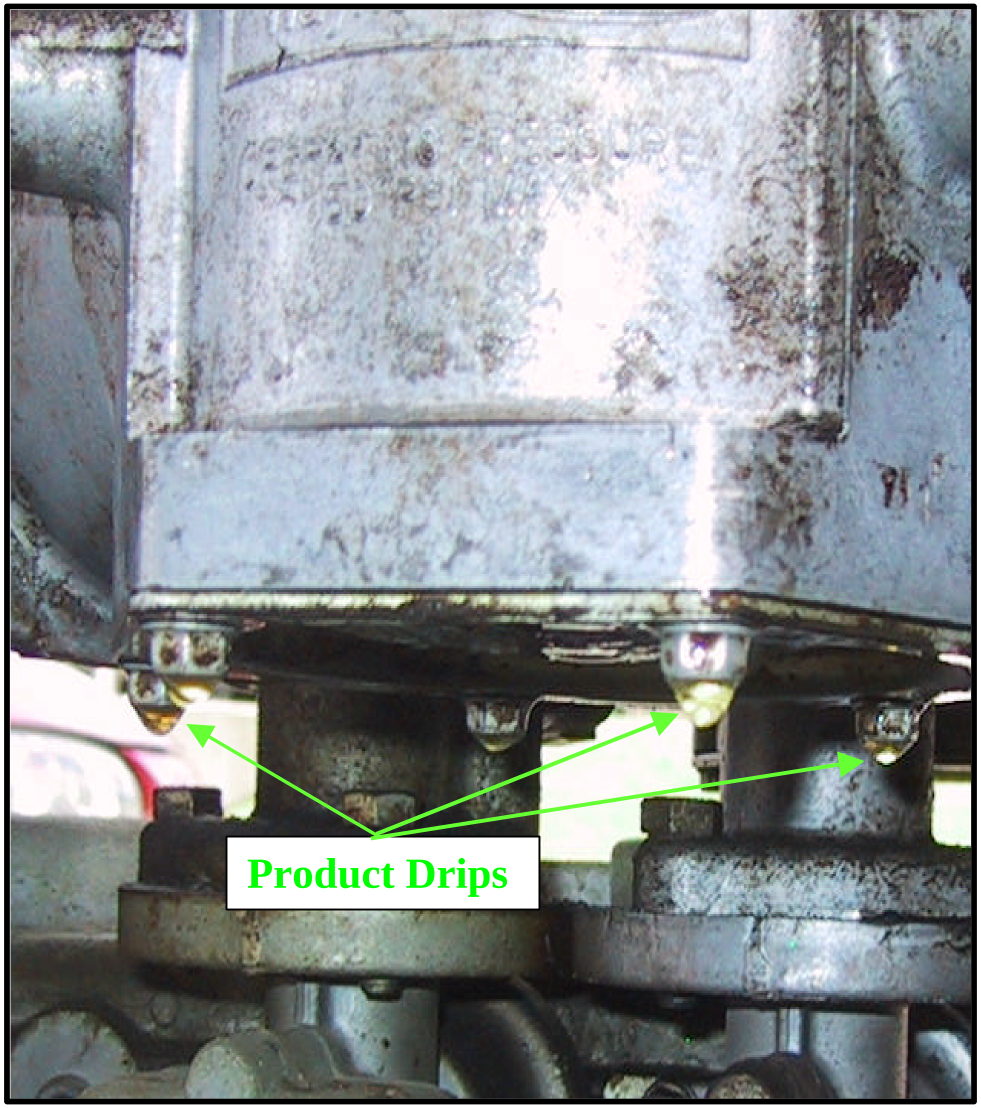


What is a Weep?

Surface appears wet.

Product finding paste changes color when applied.

No droplets of product are visible.



What is a Drip?

Droplet of product is visible

Droplet falls and another droplet forms when the pump is turned on.

Figure 5: What Was the Frequency and Severity of Leaks Observed in Dispenser Components?

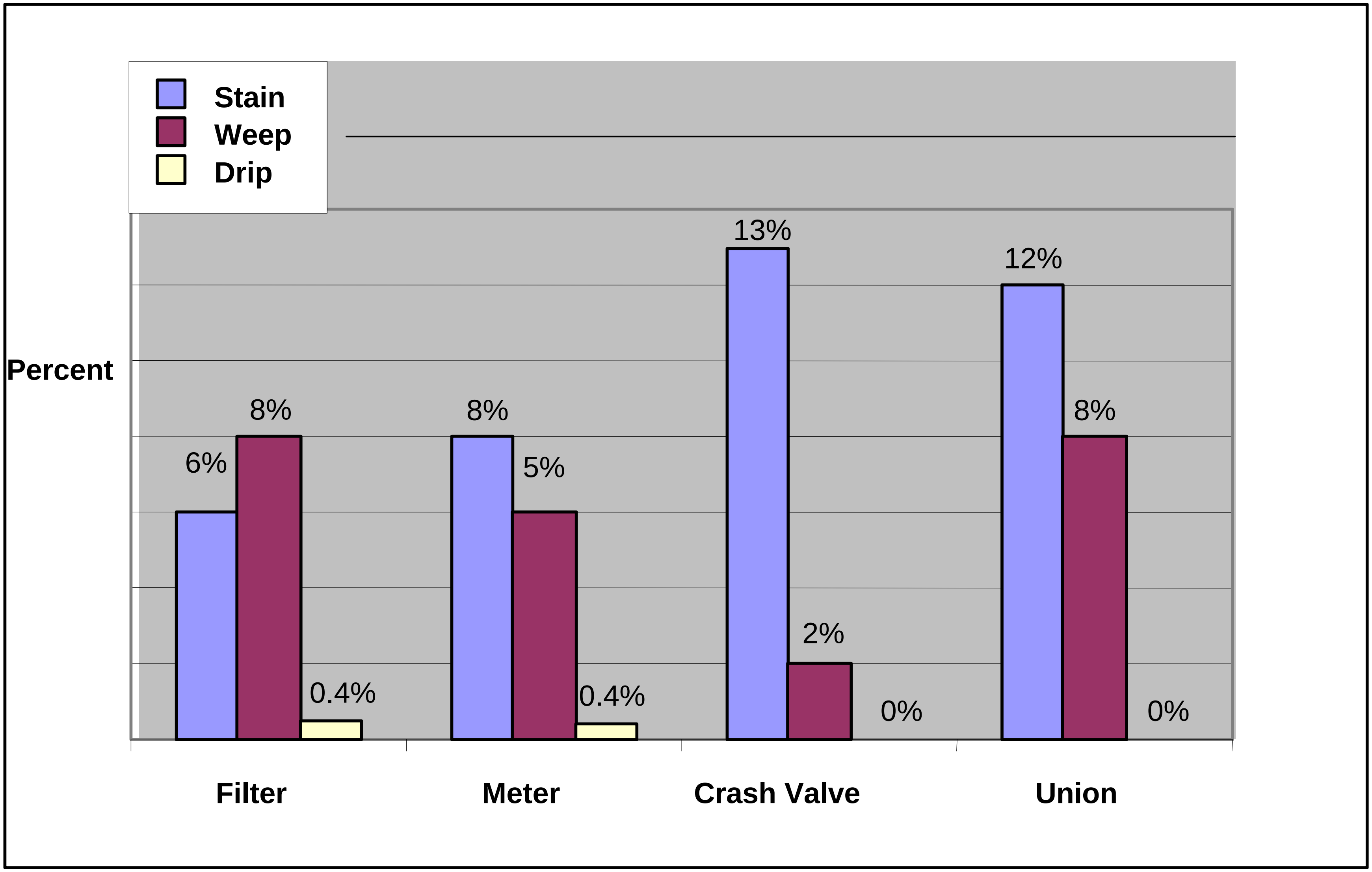


Table 5: What Was the Frequency and Severity of Leaks Observed in Dispenser Components?

	Filter		Meter		Crash Valve		Union	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Clean	383	85.5	703	86.4	280	85.4	354	79.6
Stained	26	5.8	64	7.9	42	12.8	55	12.4
Weeping	37	8.3	44	5.4	6	1.8	36	8.1
Dripping	2	0.4	3	0.4	0	0	0	0
Total Inspected	448	100.0	814	100.1	328	100.0	445	100.1

NOTE: Percentage totals do not always equal 100 because of rounding.

Filters and meters were the only actively dripping dispenser components observed during the study. Because crash valves are typically installed immediately below unions, it was sometimes difficult to distinguish stains and weeps originating from unions from those originating from the crash valve. In most cases, if the union above a crash valve showed significant staining or weeping that extended down to the crash valve, the stain or weep was attributed to the union and NOT the crash valve.

Figure 6: What was the Frequency and Severity of Leaks Observed in Suction Pumps?

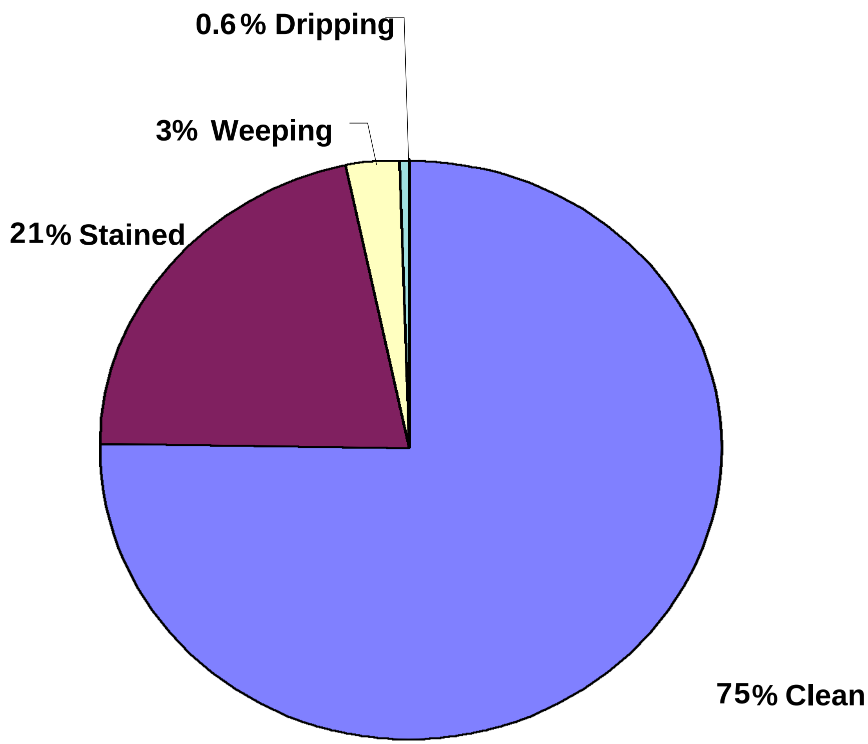


Table 6: What Was the Frequency and Severity of Leaks Observed in Suction Pumps?

	Suction Pumps	
	Number	**Percent**
Clean	**116**	**75.3**
Stained	**32**	**20.8**
Weeping	**5**	**3.2**
Dripping	**1**	**0.6**
Total Inspected	**154**	**99.9**

NOTE: Percentage total does not equal 100 because of rounding.

Of the 154 suction pumps inspected, one had a serious drip from a leak around the drive pulley bearing.

Please note that for purposes of this study, leaks from suction pumps are considered a separate category than leaks from other dispenser components.

Figure 7: What Percentage of Dispensers Were Equipped with Containment Sumps and Sensors?

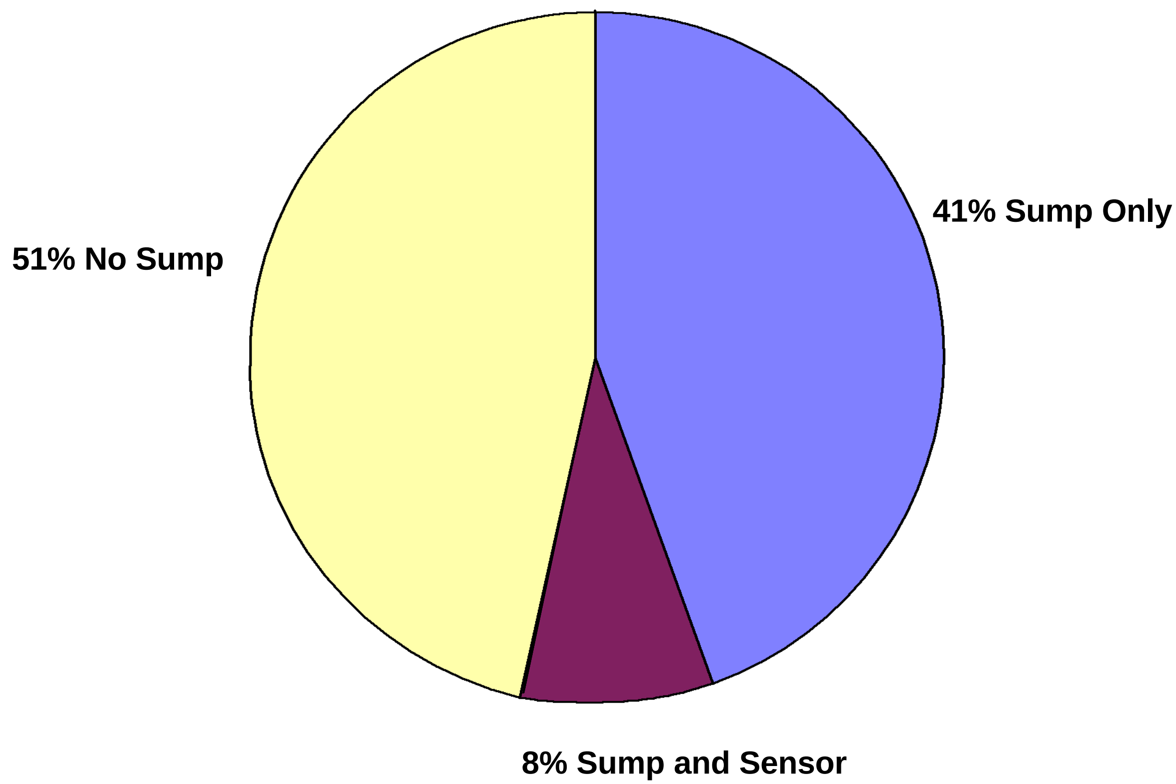


Table 7: What Percentage of Dispensers Were Equipped with Containment Sumps and Sensors?

	Dispenser Containment Sumps	
	Number	**Percent**
No Sump	**128**	**50.6**
Sump Only	**104**	**41.1**
Sump and Sensor	**21**	**8.3**
Total Dispensers Inspected	**253**	**100.0**

Some 125 (49 percent) of the dispensers that were inspected were equipped with containment sumps. Of these 125, only 21 (17 percent) were equipped with sensors. Dispenser sumps without sensors rely completely on the integrity of the dispenser sump and the secondary containment piping to channel a release back to the containment sump at the top of the tank. At facilities with multiple dispensers, successful detection of a leak in the furthest dispenser would depend on the integrity of multiple dispenser sumps and numerous secondary containment piping/sump connections.

Where feasible, soils beneath the 128 dispensers without sumps were screened for contamination using PID meters. Six suction dispensers in the study were mounted directly over tanks, water or concrete, so that soil samples could not be obtained. This is why only 122 soil samples were taken (see tables 9 and 10).

Figure 8: What Was the Depth and Frequency of Occurrence of Water and Product in Dispenser Sumps?

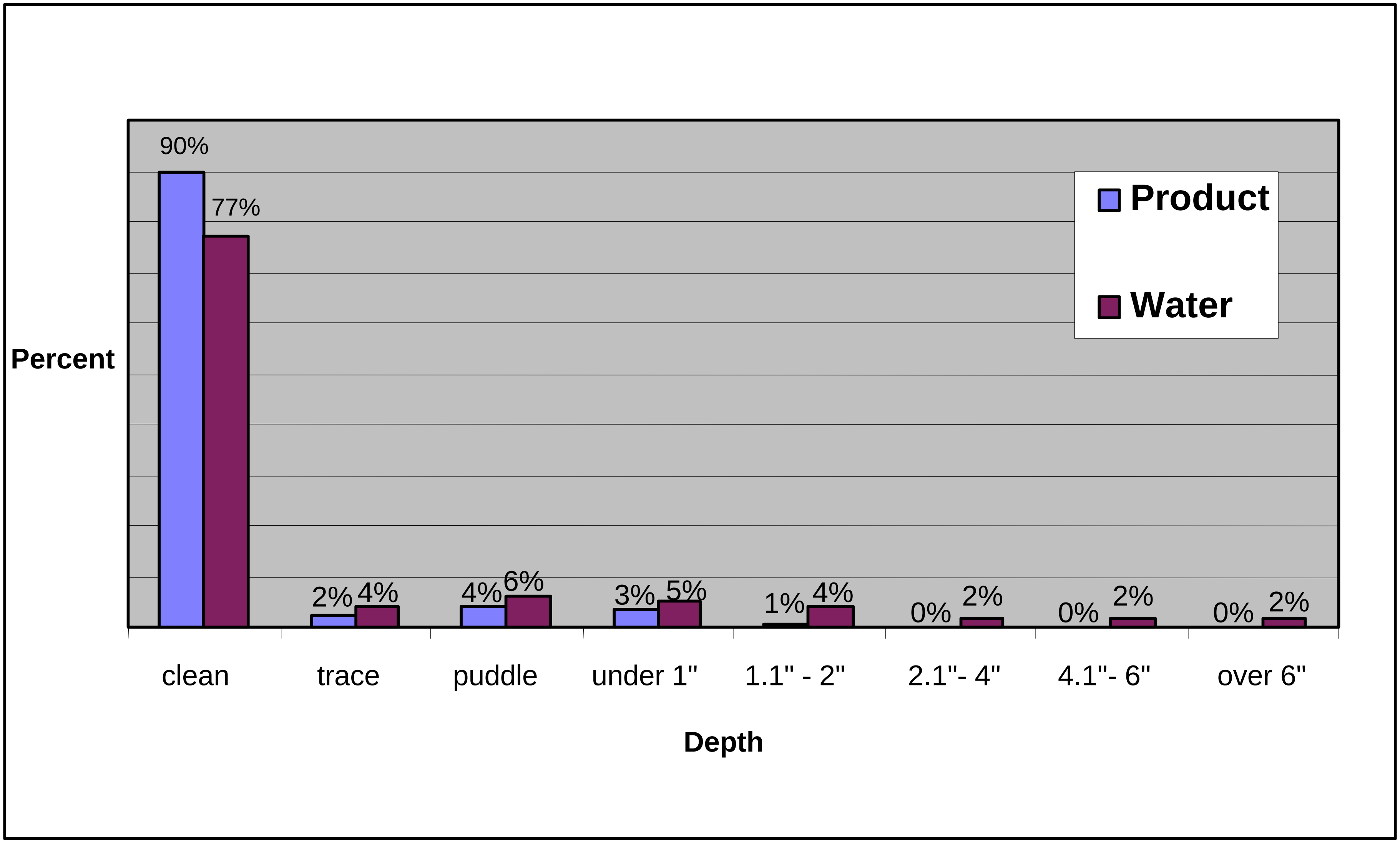


Table 8: What Was the Depth and Frequency of Occurrence of Water and Product in Dispenser Sumps?

	Product		Water	
	Number	Percent	Number	Percent
Clean	112	89.6	96	76.8
Trace[1]	3	2.4	5	4.0
Puddle[2]	5	4.0	7	5.6
Under 1”[3]	4	3.2	6	4.8
1.1” – 2”	1	0.8	5	4.0
2.1” – 4”	0	0	2	1.6
4.1” – 6”	0	0	2	1.6
Over 6”	0	0	2	1.6
Total Inspected	125	100.0	125	100.0

Only 9 percent of dispenser sumps contained more than an inch of water, and only 1 percent contained more than an inch of product. A few sumps contained both product and water.

[1]A trace was defined as a depth of liquid too shallow to measure accurately. [2]A puddle was defined as a small amount of liquid that had measurable depth but did not cover the entire bottom of the sump. [3]Where inch measurements are indicated, the entire bottom of the sump was covered with liquid and the measurement reflects the greatest measured depth.

Figure 9: What Was the Level of Soil Contamination Beneath Pressure Dispensers without Sumps?

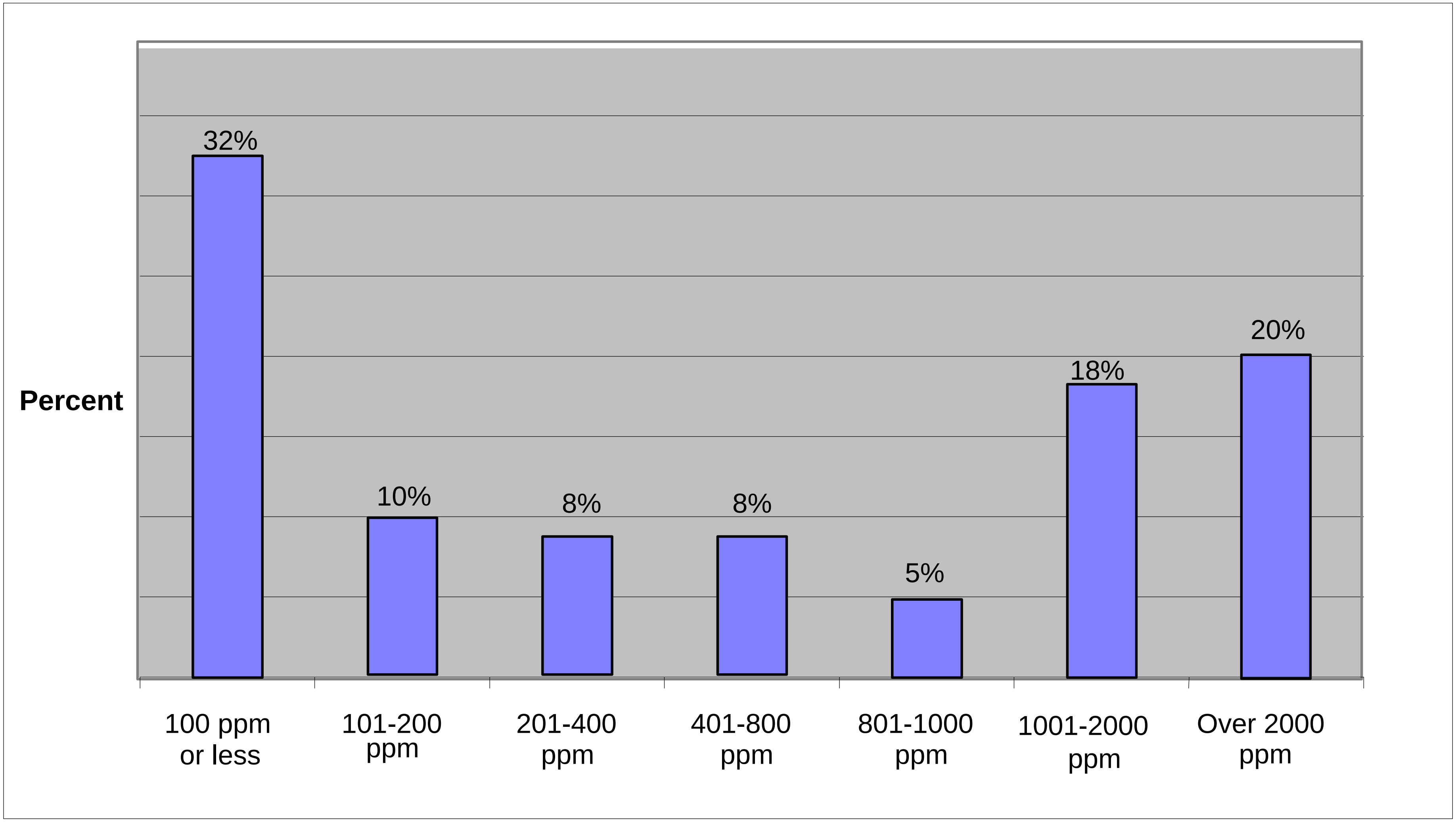


Table 9: What Was the Level of Soil Contamination Beneath Pressure Dispensers without Sumps?

	Pressure Dispenser Soil Samples	
	Number	**Percent**
100 ppm or less	**13**	**32.5**
101-200 ppm	**4**	**10.0**
201-400 ppm	**3**	**7.5**
401-800 ppm	**3**	**7.5**
801-1000 ppm	**2**	**5.0**
1001-2000 ppm	**7**	**17.5**
Over 2000 ppm	**8**	**20.0**
Total Inspected	**40**	**100.0**

At pressure dispensers without sumps, soil samples were screened for contamination using a PID meter following DEP protocol (refer to the description of the study protocol in Appendix A of this report for further details). Contamination levels less than 100 parts per million (ppm) are considered clean by Maine DEP. Thirty-two percent of pressure dispensers had PID readings below 100 ppm, while 68 percent had contamination levels greater than 100 ppm. Soil samples were taken only a few inches beneath the surface of the soil where volatilization and biodegradation of hydrocarbons would be expected to be fairly rapid. It is unlikely that residual contamination from leaks that occurred years ago would produce the elevated PID readings measured during the study.

Figure 10: What Was the Level of Soil Contamination Beneath Suction Dispensers without Sumps?

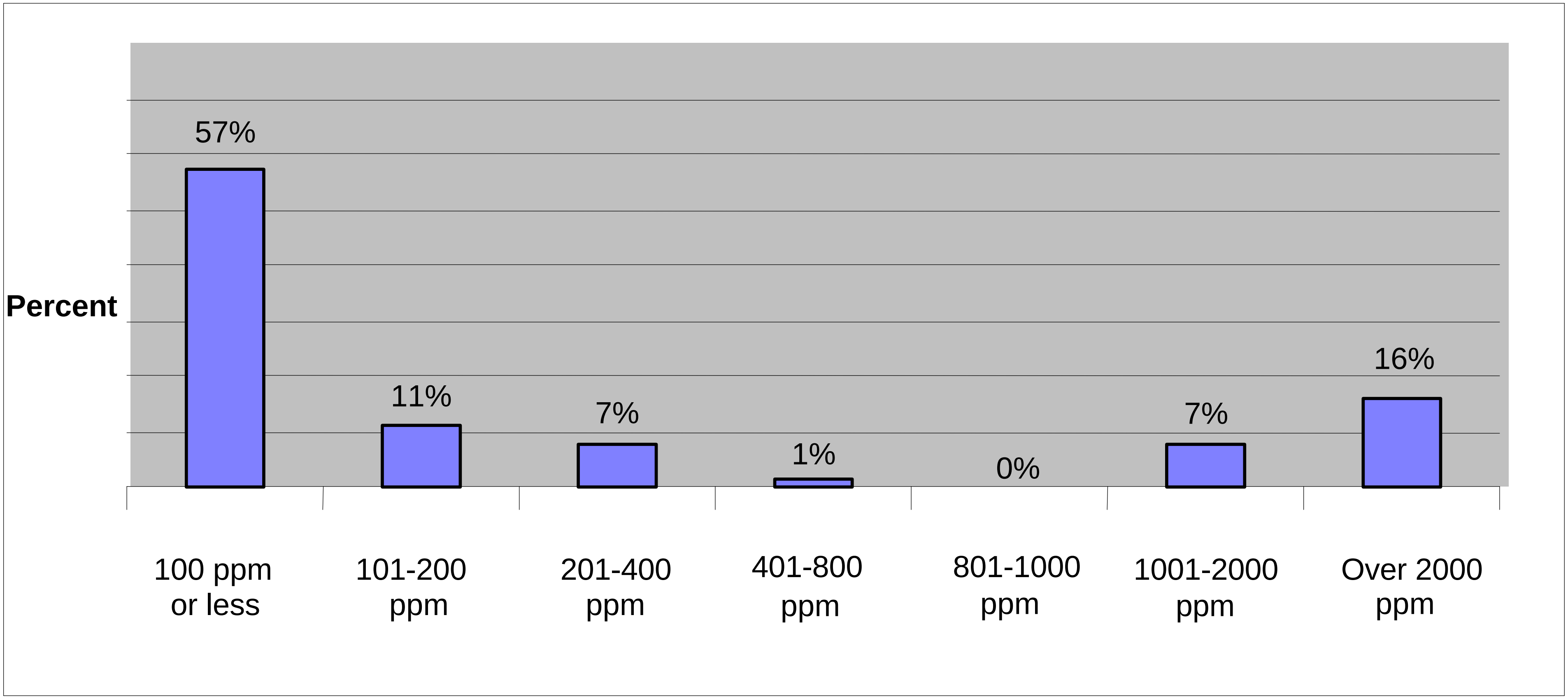


Table 10: What Was the Level of Soil Contamination Beneath Suction Dispensers without Sumps?

	Suction Dispenser Soil Samples	
	Number	**Percent**
100 ppm or less	**47**	**57.3**
101-200 ppm	**9**	**11.0**
201-400 ppm	**6**	**7.3**
401-800 ppm	**1**	**1.2**
801-1000 ppm	**0**	**0.0**
1001-2000 ppm	**6**	**7.3**
Over 2000 ppm	**13**	**15.9**
Total Inspected	**82**	**100.0**

At suction dispensers without sumps, soil samples were screened for contamination using a PID meter following DEP protocol (refer to Appendix A of this report for further details). Contamination levels less than 100 parts per million (ppm) are considered clean by Maine DEP. Fifty-seven percent of the suction dispensers had PID readings of less than 100 ppm in the soil beneath the dispenser, while 43 percent had levels greater than 100 ppm. Soil samples were taken only a few inches beneath the surface of the soil where volatilization and biodegradation of hydrocarbons would be expected to be fairly rapid. It is unlikely that residual contamination from leaks that occurred years ago would produce the elevated PID readings measured during the study.

Figure 11: What Was the Frequency and Severity of Leaks Observed from Submersible Pumps?

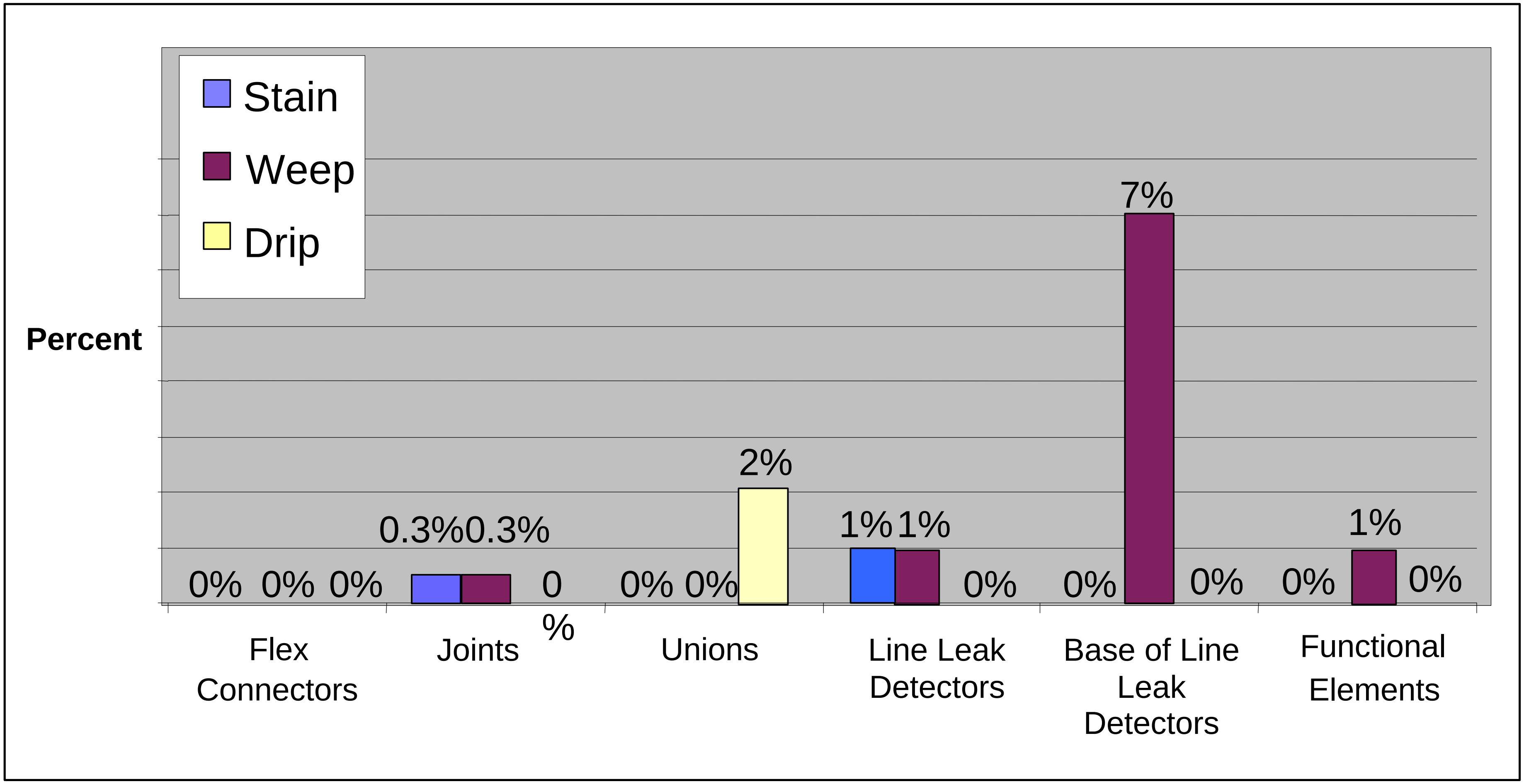


Table 11: What Was the Frequency and Severity of Leaks Observed from Submersible Pumps?

	Flex Connectors		Joints		Unions	
	Number	Percent	Number	Percent	Number	Percent
Clean	22	100.0	594	99.3	50	98.0
Stained	0	0.0	2	0.3	0	0.0
Weeping	0	0.0	2	0.3	0	0.0
Dripping	0	0.0	0	0.0	1	2.0
Total Inspected	22	100.0	598	99.9	51	100.0

	Line Leak Detectors		Base of Line Leak Detectors		Functional Elements	
	Number	Percent	Number	Percent	Number	Percent
Clean	105	98.1	100	93.5	106	99.1
Stained	1	0.9	0	0.0	0	0.0
Weeping	1	0.9	7	6.5	1	0.9
Dripping	0	0.0	0	0.0	0	0.0
Total Inspected	107	99.9	107	100.0	107	100.0

Although stains were the most commonly observed evidence of leakage in dispensers, they were virtually absent from submersible pumps. The threaded joint between the base of line leak detectors and submersible pump manifolds was the location where weeping product was most frequently observed. In a number of cases, submersible pump containment sumps had very strong gasoline odors when they were initially opened, but no evidence of leakage could be located.

Figure 12: What Percentage of Submersible Pumps Were Installed in Containment Sumps with Sensors?

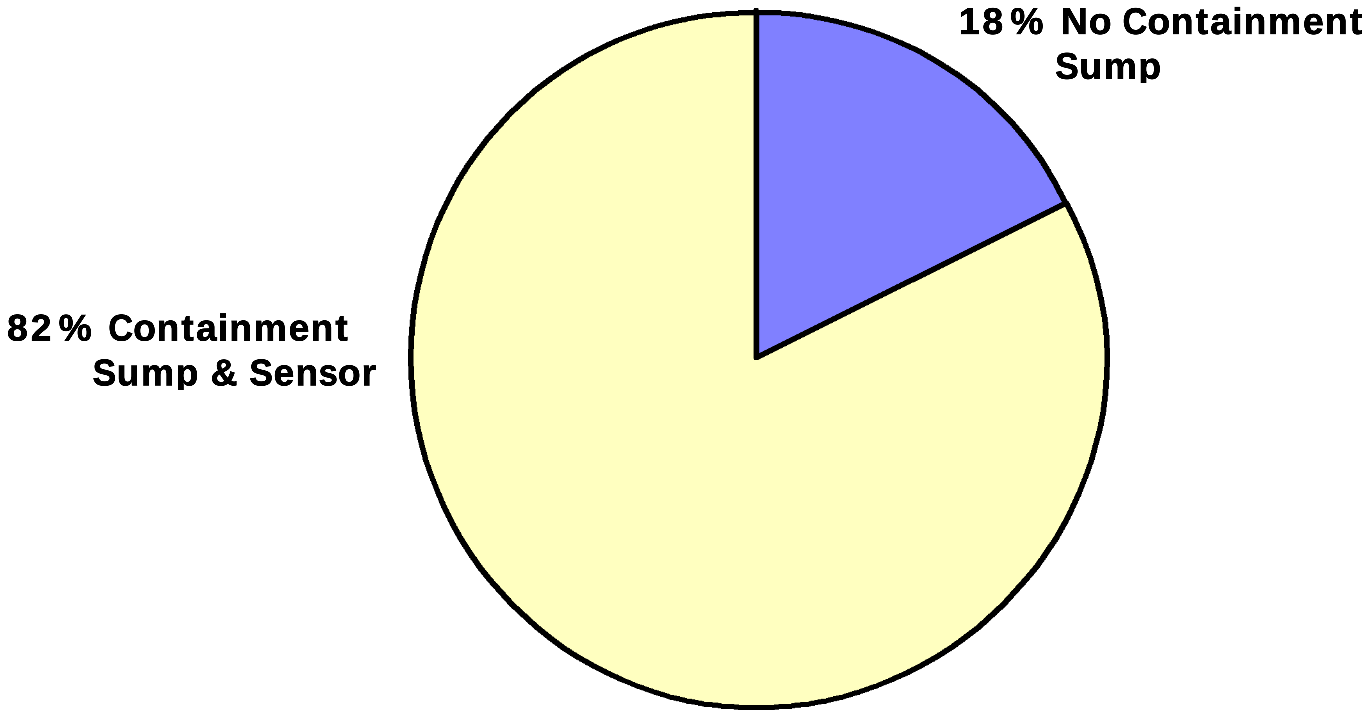


Table 12: What Percentage of Submersible Pumps Were Installed in Containment Sumps with Sensors?

	Submersible Pumps	
	Number	Percent
No Containment Sump	**19**	**17.9**
Containment Sump and Sensor	**87**	**82.1**
Total Submersible Pumps Inspected	**106**	**100.0**

There was one facility where two submersible pumps were installed in one containment sump. As a result, the total number of submersible pump sumps inspected was 106, while the number of submersible pumps inspected was 107. Nine tank top containment sumps that contained various fittings, but did NOT contain submersible pumps, were also encountered in the course of the study. These containment sumps without pumps are not included in the study statistics. All of the submersible pump containment sumps inspected during this study were equipped with sensors.

Figure 13: What Was the Depth and Frequency of Occurrence of Water and Product in Submersible Pump Sumps?

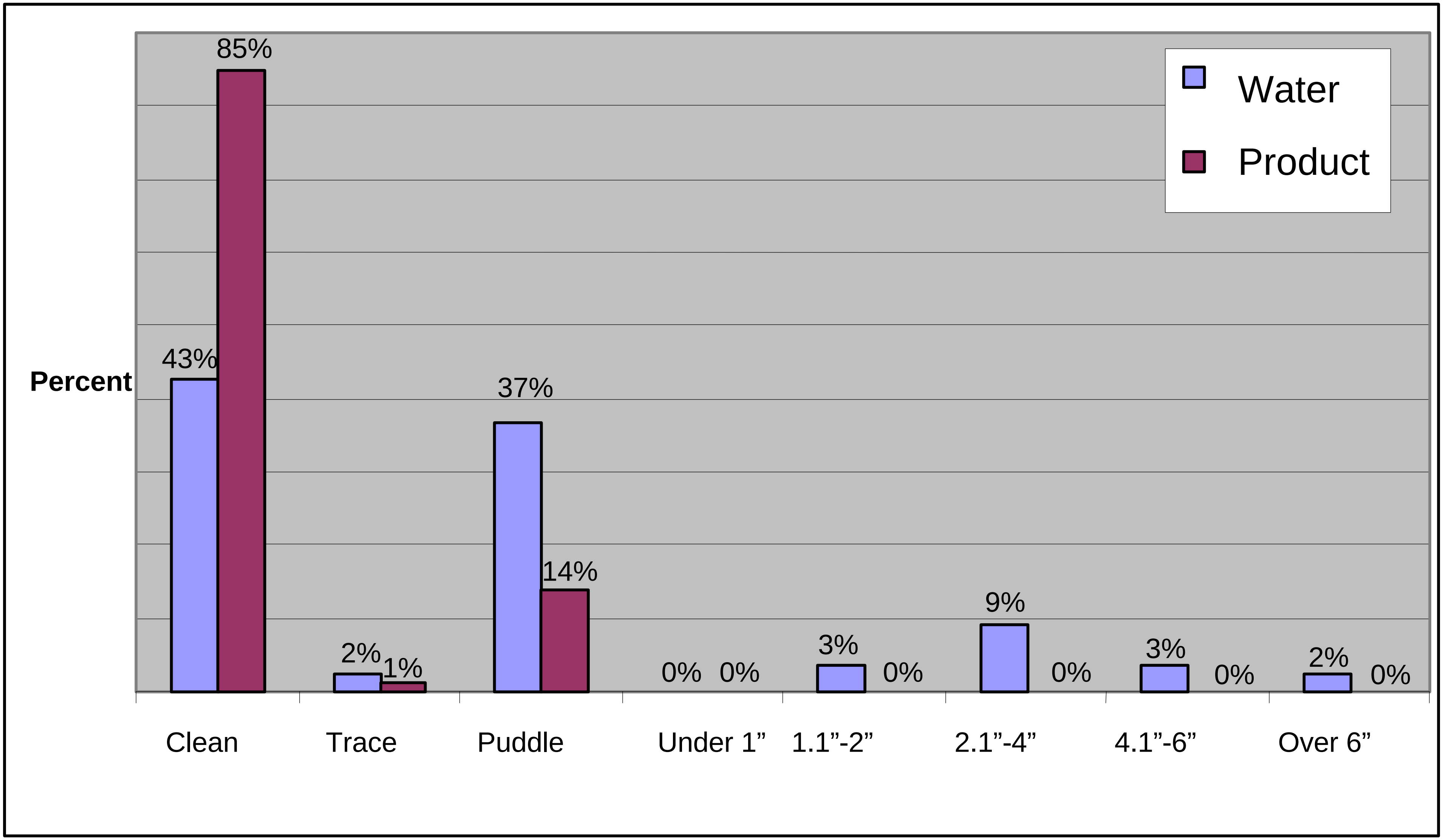


Table 13: What Was the Depth and Frequency of Occurrence of Water and Product in Submersible Pump Sumps?

	Water		Product	
	Number	Percent	Number	Percent
Clean	37	42.5	74	85.1
Trace	2	2.3	1	1.1
Puddle	32	36.8	12	13.8
Under 1”	0	0.0	0	0
1.1”-2”	3	3.4	0	0
2.1”-4”	8	9.2	0	0
4.1”-6”	3	3.4	0	0
Over 6”	2	2.3	0	0
Total Inspected	87	99.9	87	100.0

NOTE: Percentage totals do not always equal 100 because of rounding.

A trace was defined as a depth of liquid too shallow to measure accurately. A puddle was defined as a small amount of liquid that had measurable depth but did not cover the entire bottom of the sump. Where inch measurements are indicated, the entire bottom of the sump was covered with liquid and the measurement reflects the greatest measured depth. Some 18 percent of submersible pump sumps contained more than an inch of water, but none contained more than a puddle of product.

Figure 14: What Was the Level of Contamination Beneath Submersible Pumps without Containment?

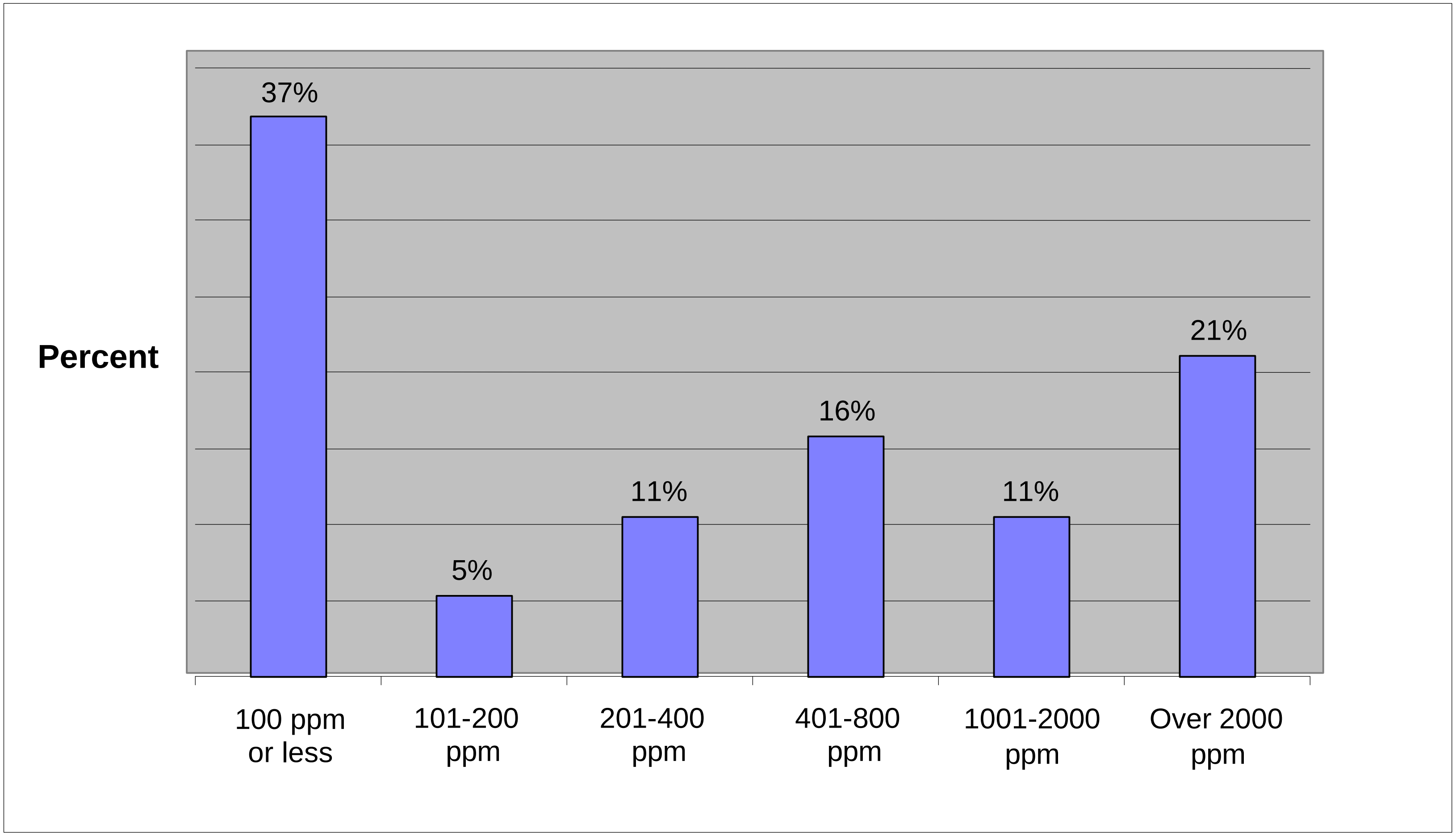


Table 14: What Was the Level of Contamination Beneath Submersible Pumps without Containment?

	Soil Beneath Submersible Pumps	
	Number	**Percent**
100 ppm or less	**7**	**36.8**
101-200 ppm	**1**	**5.3**
201-400 ppm	**2**	**10.5**
401-800 ppm	**3**	**15.8**
1001-2000 ppm	**2**	**10.5**
Over 2000 ppm	**4**	**21.1**
Total Inspected	**19**	**100.0**

At submersible pumps without sumps, soil samples were screened for contamination using a PID meter following DEP protocol (refer to the description of the study protocol in Appendix A of this report for further details). Contamination levels less than 100 parts per million (ppm) are considered clean by Maine DEP. Thirty seven percent of the soil samples from beneath submersible pumps had PID readings of less than 100 ppm, while 63 percent had levels greater than 100 ppm.

RESULTS

- **What was the frequency and severity of leakage from specific components of petroleum dispensers such as meters, filters, unions, and crash valves?**

The dispenser component most frequently exhibiting some sign of a leak (stain, weep, or drip) was the union, while the more severe leaks (drips) were most frequently observed in filters and meters. Some 20.4 percent of the unions inspected showed some evidence of a leak. Crash valves, filters and meters shared approximately the same overall frequency of leakage at 14.6, 14.5 and 13.6 percent respectively. In terms of the most severe leaks (drips), filters and meters were the same at 0.4 percent. Weeping filters and unions were observed 8.3 and 8.1 percent of the time respectively, while 5.4 percent of meters and 1.8 percent of crash valves were found to be weeping.

- **What was the frequency and severity of leakage from specific components present on or adjacent to submersible pumps?**

The submersible pump component most frequently exhibiting some sign of a leak (stain, weep or drip) was the base of line leak detectors at 6.5 percent. Next in order of frequency were unions at 2.0 percent, line leak detectors at 1.9 percent, functional elements at 0.9 percent and threaded joints at 0.7 percent. In terms of the most severe leaks observed, 2.0 percent of unions were found to be dripping. Weeps were observed at 6.5 percent of line leak detector bases, while 0.9 percent of functional elements and line leak detectors, and 0.3 percent of threaded joints exhibited weeps. Staining was rarely observed in submersible pump sumps. Only 0.9 percent of line leak detectors and 0.3 percent of threaded joints showed stains.

- **What was the frequency and severity of leaks observed from suction pumps?**

Staining was observed on suction pumping units 20.8 percent of the time, 3.2 percent of suction pumps were weeping and 0.6 percent were dripping.

- **What percentage of dispensers and submersible pumps were equipped with containment sumps and leak detection sensors?**

Some 49.4 percent of dispensers were equipped with containment sumps, but only 16.8 percent of these dispenser sumps were equipped with sensors.

Some 82.1 percent of submersible pumps were installed within containment sumps, and 100 percent of these were equipped with sensors.

- **What percentage of containment sumps had water in them, and how much water was present?**

A measurable amount of water was found in 19.2 percent of dispenser sumps, though only 8.8 percent had more than an inch of water.

Water was found in 55.2 percent of submersible pump sumps, and 18.4 percent had more than 1 inch of water.

- **What percentage of containment sumps had product in them, and how much product was present?**

Some 8.0 percent of dispenser sumps had a measurable amount of product in them, though only 0.8 percent had more than an inch of product.

Some 13.8 percent of submersible pump sumps had product in them, although in all cases, the amount of product present was no more than a puddle.

- **What was the level of soil contamination present beneath dispensers and pumps that were not equipped with containment sumps?**

Some 50.8 percent of all dispensers without containment sumps had PID readings of greater than 100 ppm, the DEP's criterion for contamination used in this study. Some 27.9 percent of all dispensers without containment sumps had contamination levels greater than 1,000 ppm.

Contamination greater than 100 ppm was measured beneath 42.7 percent of the suction dispensers and 67.5 percent of the pressure dispensers. Contamination greater than 1,000 ppm was measured beneath 23.2 percent of the suction dispensers and 37.5 percent of the pressure dispensers.

Some 63.2 percent of submersible pumps without containment sumps had PID readings of greater than 100 ppm; Some 31.6 percent had contamination levels greater than 1,000 ppm.

DISCUSSION

- **Should containment under pumps and dispensers be required at all motor fuel facilities?**

Three kinds of data gathered during this study could be used to answer this question. These data sources are:

- The number of actively leaking (dripping) dispensers and pumps.
- The frequency of occurrence of liquid product in dispenser and submersible pump sumps.
- The frequency and severity of contamination in soils beneath dispensers.

These three data sources do not seem to be entirely in agreement. On the one hand, the soil contamination data indicate that one-quarter to one-third of dispensers and submersible pumps show significant soil contamination over 1,000 ppm, and half to nearly two-thirds show soil contamination levels that exceed the DEP contamination threshold of 100 ppm used in this study. On the other hand, only a few percent of dispensers and submersible pumps were observed to be actively leaking (dripping), and only 8 to 14 percent showed evidence of product accumulation in containment sumps (see Table 15 below).

Our working hypothesis at the initiation of the study was that the percentage of dispensers and submersible pumps with active leaks would roughly correspond to the percentage of dispensers and submersible pumps with significant product accumulation in containment sumps or significant soil contamination where containment sumps were absent. The field data, however, point to a much lower frequency of active leaks (drips) relative to the frequency of soil contamination. Qualitative review of the data also indicate that there is no obvious relationship between the degree of soil contamination and the presence of stains or weeps in a dispenser, nor is there a relationship between the age of the facility and the degree of soil contamination.

	Dispensers	Submersible Pumps
Dripping Component	2%	1%
Product Present in the Sump (puddle or greater)	8%	14%
Soil Contamination Greater than 100 ppm	51%	63%
Soil Contamination Greater than 1,000 ppm	28%	32%

Table 15. Comparison of the frequency of observed leaks and product accumulation in sumps to the levels of contamination observed beneath dispensers and submersible pumps. In this table, suction pump drips are included with dispenser drips.

Why is the observed frequency of drips and the presence of product in containment sumps much less than the observed frequency of significant soil contamination? The data from this study do not provide a definitive answer to this discrepancy, but following are some possible explanations:

- It is possible that shallow soil contamination lingers for some months or even longer after the source of the leak has been stopped. The rate of natural attenuation of hydrocarbon contamination in soils is highly variable and depends to a great extent on site conditions that were not evaluated during this study. Consequently, the soil contamination data may represent a longer term look at what is happening beneath dispensers and submersible pumps than the "snapshot" picture that is represented by the observed drips and product accumulations in containment sumps. A corollary of this hypothesis is that leaks are fairly frequent but transient (see following explanation).

- It is possible that leaks may occur frequently but that they are repaired fairly quickly. A number of facilities that were inspected had recently had annual inspections. It is not known how many leaks, if any, might have been repaired, or how much product might have been removed from containment sumps during the annual inspections.

- It is possible that maintenance activities such as cleaning strainers, changing filters or replacing line leak detectors routinely cause spillage that could produce the observed soil contamination. While spillage into sumps is subsequently cleaned up so that it was not observed in this study, spillage into soils is less conspicuous, more difficult to clean up, and is more likely to be left in place.

- It is possible that the protocol used to inspect the dispensers was not effective in characterizing all leaks. We are aware of one instance where a meter leak that was initially identified as a "weep" turned into a substantial "drip" after several gallons of gasoline had been dispensed. The study protocol did not call for gasoline to be dispensed when weeps were observed, so we do not know how frequently this type of situation may have occurred.

- It is possible that the protocol used to inspect submersible pumps was not effective in detecting all leaks. Quite a number of submersible pump sumps had very strong odors of gasoline when they were initially opened, though subsequent inspection was not able to detect any level of leakage in the submersible pump or the adjacent components.

Because long-standing field evidence, as well as the soil contamination data from this study indicate that half of active dispensers and nearly two-thirds of active submersible pumps have levels of soil contamination that exceed allowable DEP contamination levels beneath them, it is recommended that all dispensers and submersible pumps be equipped with containment sumps.

- **What steps could be taken to minimize contamination resulting from leaks in dispensers and pumps?**

The following are steps that could be taken to reduce the frequency and severity of releases from motor fuel dispensers and pumps.

- **Routinely Inspect the Inside of Dispenser Cabinets.**
  Many leaks inside dispenser cabinets are plainly visible if someone takes the time to look for them. While removing dispenser cabinet doors is typically a simple task, only rarely do facility operators bother to look inside dispensers for evidence of a leak. Routine visual inspections of the inside of dispenser cabinets could readily detect significant leaks before they become major releases.

  While leaks inside submersible pump sumps should also be plainly evident, the inspection of submersible pumps typically involves the removal and replacement of heavy covers that are oftentimes located in traffic areas where there is significant danger of being hit by vehicular traffic. Because of safety concerns, the routine inspection of submersible pump sumps by facility operators is not recommended.

- **Install Sensors in Dispenser Sumps.**
  Installation of continuously monitored sensors in the bottoms of dispenser sumps is a step that could be used instead of routine inspections of the inside of dispenser cabinets at those facilities equipped with dispenser containment. Only 17 percent of dispenser sumps in Maine are equipped with sensors. This means that for dispenser leaks to be detected at the remaining 83 percent of the dispensers with sumps, product must accumulate and flow distances ranging from tens to hundreds of feet back to the tank top sump before the leak is detected. There are typically many penetrations in dispenser and tank top sumps that can allow the leaked product to escape the secondary containment and enter into the environment before it can be detected by remote sensors.

  Several incidents have occurred in Maine where major releases resulted from leaks in dispenser and submersible pump sumps. Anecdotal evidence from California where secondary containment sumps were required to be leak tested indicates that half of the installed sumps leak. The primary source of leaks is reported to be the point of entry of piping and electrical conduit into the sumps. This bodes ill for the majority of secondary containment systems in Maine where a dispenser release may need to travel through several dispenser sumps before activating the sensor in the submersible pump sump. Installation of sensors in dispenser sumps would minimize the necessity for all connections in a secondary containment system to be liquid tight in order for the system to be effective in containing and detecting releases. For dispenser sensors to be fully effective, the following two steps would also have to be implemented.

- **Test Dispenser and Submersible Pump Sumps for Leaks.**
  If sensors in dispenser or submersible pump containment sumps are to be effective in detecting leaks, the sumps must be liquid tight. Experience has shown that many sumps are not liquid tight. A review of installation instructions for several popular brands of sumps reveals that installation instructions do not specify that sumps be tested at the time of installation. Several states (e.g., Florida and California) have

responded to this issue by requiring periodic testing of secondary containment systems.

In response, several manufacturers have developed equipment specifically designed to detect small leaks in containment sumps. The procedure typically requires that the containment sump be filled with water and the water level monitored for a period of time. To prevent the secondary piping from being filled with water (which would freeze in the winter and could cause problems) the secondary piping must be isolated from the sumps. Sumps, especially dispenser sumps, are typically cramped and difficult spaces in which to work, making this procedure burdensome.

An alternative approach that may be slightly less protective but significantly easier to execute would be to require that sumps be liquid tight to a level that is a few inches higher than the level at which the sensor installed in the sump would trigger an alarm. Because most sensors will alarm with only a few inches of liquid, and some will sense fractions of an inch of liquid, only the bottom portion of a sump would need to be liquid tight to be effective in detecting leaks. Most dispenser sumps have one-piece bottoms with no penetrations, so it should be relatively straightforward to test the bottoms of these sumps for liquid tightness. To help ensure that alarms are not ignored, this strategy should also include the requirement that power to the relevant pump or dispenser be cut off when the sensor detects the presence of a liquid.

- **Ensure that Sumps are Adequately Sized.**
  In the course of conducting this study, we observed quite a few dispensers where the footprint of the dispenser was substantially larger than the opening of the dispenser sump. When this is the case it is very likely that meter or filter leaks might fall on the dispenser island rather than inside the dispenser sump. The product can then flow between the dispenser island and the containment sump and escape detection. If dispenser sumps are to be effective in detecting leaks and containing releases, the sump must be able to capture all liquid that falls from any of the components of the dispenser that are most likely to leak, including meters and filters.

RECOMMENDATIONS

The following changes to Maine's regulatory requirements for underground storage systems are recommended in order to provide increased protection against releases from dispensers and submersible pumping systems:

- Require appropriately sized dispenser sumps at all new dispenser installations, including suction dispensers. Require containment sumps at all newly installed submersible pumps. Require sensors in all new dispenser and submersible pump sumps

- Require all existing dispenser sumps to have sensors. The sensors should cut off power to the relevant pump or dispenser when liquid is detected to ensure that alarms are not ignored. At the time of sensor installation, require verification of the integrity of the sump up to a level that is a few inches higher that the liquid level required to trigger the sensor.

- At installation, all sumps should be tested to be water tight up to a level that is above the highest penetration fitting. This testing should be conducted before piping is buried so that any water that enters the piping interstitial space can be drained out before the piping is backfilled. Every 5 years thereafter, all sumps should be tested for tightness up to a level that is a few inches above the liquid level that will trigger the sensor.

- Existing facilities without dispenser sumps should be required to conduct and document weekly inspections of the inside of dispensers. A timetable should be established to retrofit all existing facilities without dispenser containment with dispenser sumps.

- Existing facilities equipped with sumps that are substantially smaller than the dispenser footprint should be required to conduct weekly inspections of the inside of the dispenser, replace the sump, or add a diverter or drip pan to direct drips from the dispenser into the containment sump. New installations should require that the dispenser sump have essentially the same top opening dimensions as the base of the dispenser cabinet, or the dispenser cabinet should include diverter plates or drip pans to direct dispenser leaks into the dispenser sump.